# Simulation modeling of plasma and neutral transport in closed divertor configuration of LHD

G. Kawamura[1*], M. Kobayashi[1], Y. Tomita[1], S. Masuzaki[1], T. Morisaki[1], Y. Feng[2]

[1] *National Institute for Fusion Science, 322-6 Oroshi-cho, Toki 509-5292 Japan*
[2] *Max-Planck-Institut für Plasmaphysik, Greifswald, Euratom Assoc., 17491 Greifswald, Germany*
** Email: kawamura.gakushi@nifs.ac.jp*

The Large Helical Device (LHD) has been upgraded with the installation of closed divertor, which currently covers 20% of the full torus. The first experimental campaign with the closed divertor has been conducted in fiscal year of 2010, and has demonstrated the efficient neutral compression by the dome and the baffle structure, up to 10 times larger than the previous open divertor region [1,2]. The rest of the torus is now under construction for the full closed divertor configuration. The design of the divertor was mainly based on the three dimensional neutral transport simulation with EIRENE [3]. For understanding the compression mechanism as well as the divertor plasma characteristics in the closed divertor configuration, however, consistent treatment of the plasma-neutral interaction including the plasma-facing component is of great importance.

The task is undertaken by utilizing the new version of the 3D edge plasma transport code, EMC3[4], which is extended being capable of including the divertor legs of LHD with strong flux tube deformation due to the magnetic shear, which usually prevents construction of feasible field aligned 3D grid. The calculation grid employed in this work is constructed from the magnetic field to be aligned along them. Since the helical field has large magnetic shear apart from the core region, consistent arrangement of a single set of grid is difficult from the geometrical point of view. The simulation in the previous work [5] approximated the divertor legs on the half way to the divertor plates by shifting the Bohm boundary condition slightly upstream, 1~2 m. This was considered a reasonable assumption for the open divertor configuration, where the most relevant transport physics for the LHD divertor was found in the stochastic region, upstream of the divertor legs. For the closed divertor configuration, however, the inclusion of full divertor legs is prerequisite for understanding the role of the baffle structure and the dome in the new closed divertor configuration. In order to include the full divertor leg in the calculation, four new grid systems are connected to the SOL grid. They are generated separately to cover the divertor legs and share the grid points on the surface of the SOL grid around the X-points.

We installed baffle plates to simulate the closed divertor configuration and carried out simulation with the new grid system and obtained a plasma distribution in a hydrogen discharge. Neutral compression ratio and density dependence of neutral on the plasma density are investigated by a parameter survey. The detailed physical mechanism of the scaling law is described in the paper.

[1] S. Masuzaki *et al.*, Fus. Eng. Des. **85** (2010) 940
[2] S. Masuzaki *et al.*, Plasma Fus. Res. **6** (2011) 1202007
[3] M. Shoji *et al.*, Nucl. Mater., **390-391** (2009) 490
[4] Y. Feng *et al.*, Contrib. Plasma Phys. **44** (2004) 57
[5] M. Kobayashi *et al.*, Fus. Sci. Technol. **58** (2010) 220